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BIOLOGICAL EVALUATION
Western Spruce Budworm

Santa Fe National Forest
and Jemez Indian Pueblo
New Mexico

1980

Forest Pest Management
State and Private Forestry
Southwestern Region, USDA, Forest Service
517 Gold Avenue, SW
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ABSTRACT

The western spruce budworm, Choristoneura occidentalis Free., outbreak continued to increase on the Jemez East and Central entomological units and the Coyote Ranger District. Mixed conifer stands were most heavily defoliated on the Jemez East unit and the Coyote Ranger District. A total of 70,545 acres of visible defoliation was recorded on the Santa Fe National Forest and adjoining lands in 1980.

Average egg mass densities increased in all areas sampled, and population levels and subsequent defoliation are expected to increase substantially in 1981 on the Jemez East unit and Coyote Ranger District. No tree damages have resulted from the outbreak in these areas; however, if it continues at current levels or increases, tree damage can be expected. Although populations are increasing on the Jemez Central unit, the level of infestation and resulting damage will be less than those expected on the East unit.

A slight increase was noted on the Jemez West unit; however, the populations remain low as a result of the carbaryl treatment in 1977.

Pest management alternatives and recommendations are discussed in this evaluation report.

INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Free., continued to cause defoliation in mixed conifer stands on the Santa Fe National Forest. Visible defoliation[1/] was first reported on the Jemez East and Jemez West entomological units in 1976 and on the Jemez Central entomological unit in 1977. In 1977, the Jemez West unit was aerially treated with carbaryl to suppress the budworm infestation.

Egg mass density surveys were conducted in all three entomological units and on the Coyote Ranger District north of the San Pedro Parks Wilderness Area. Results are summarized in this evaluation, and management alternatives and recommendations are presented.

TECHNICAL INFORMATION

Insect.--Western spruce budworm, Choristoneura occidentalis Freeman

Hosts.--Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History.--The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

Stage	Time	Location on Host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June	On buds and strobile
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation.

1. Young larvae feeding on newly expanding buds and strobile.
2. Mature larvae consuming current year's needles.
3. Shoots webbed together by larvae.
4. Webbed shoots turning brown and falling from trees.
5. Defoliation most evident in upper crowns of trees.
6. Trees dying from the top downward after several years of heavy defoliation.

1/ Visible defoliation based on aerial detection surveys.

Extent of Defoliation in 1980.--Defoliation to host type was visible from the air on 70,545 acres of the Santa Fe National Forest. Intensity of defoliation was light, 35,115 acres; moderate, 28,750 acres; and heavy, 6,680 acres. Figures 1-5 show the extent and intensity of defoliation in 1980.

BIOLOGICAL INFORMATION

Relative Abundance of Pest

Methods.--Egg mass surveys were conducted in early August to provide an indication of larval populations and subsequent defoliation for 1981. Two branches (70 cm in length) were cut from opposite sides of the midcrown of three sample trees on plots located in all three entomological units and on the Coyote Ranger District near the San Pedro Parks Wilderness Area. Sample trees met the following criteria: Douglas-fir, dominant or codominant; 30-50 feet in height; relatively open-grown with a full crown; and some budworm feeding evident, but not severely defoliated or top-killed. Each branch was individually bagged in cloth sacks, tied securely and labeled, and transported to a laboratory for examination. Foliage was stored in a walk-in cooler at about 40° F until examined.

In the laboratory, foliage was examined under ultraviolet light for egg masses. Needles with egg masses were classed as from current year's foliage or a previous year's foliage and kept separate in labeled boxes. New and old egg masses were separated by an experienced laboratory technician. All egg masses on current year's foliage were classed as new and their characteristics formed the basis for aging egg masses found on the previous year's foliage.

Defoliation estimates for 1981 were determined from the density of 1980 egg masses using the following information presented by McKnight et al. (1970):

Egg mass density[a/]	Predicted defoliation class[b/]
1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static"infestations Moderate for "increasing" infestations
34.10	Moderate for "static" infestations Heavy for "increasing" infestations

a/ Number of egg masses per square meter of foliage.
b/ Defoliation class limits (percent of new growth).
Undetectable = 5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = 65 percent

Results and Discussion.--Egg mass data show that larval densities and defoliation will increase in all three entomological units in 1981. Results of the surveys are presented separately for each entomological unit in Table 1.

Jemez East Entomological Unit.--This unit includes part of the Tesuque and Espanola Ranger Districts. Egg mass surveys on this unit showed an increase in numbers of egg masses per square meter of foliage from 18.9 in 1979 to 58.3 in 1980. This represents a buildup ratio of 3.1:1. Heaviest defoliation occurred east of the Baca Location No. 1 from Pajarito Canyon south to American Springs, and east of Canyon del Norte on the Tesuque Ranger District. Heavy and moderate defoliation occurred on over 21,000 acres. Data collected on plots established for the Western Spruce Budworm Suppression and Evaluation Project to determine seedling and sapling top-kill and mortality[2/] show that no significant damage has occurred yet as a result of the budworm infestation.

Budworm populations can be expected to remain at high levels in 1981. Numbers of acres in the moderate and heavy defoliation classes can be expected to increase in 1981. No tree damages or losses have resulted from the budworm infestation. This is due in part to the relatively moderate populations that have occurred on this unit up until 1980. Areas such as the Carson and Kaibab National Forests that have experienced population levels comparable to those predicted for the Jemez East unit in 1981 have reported significant tree damages. Damages are primarily top-kill in seedlings, saplings and pole-size timber, and to a lesser extent in sawtimber size trees. If populations continue at the current level or increase, similar losses could be evident on the Jemez East Unit by 1983.

Jemez Central Entomological Unit.--This unit is primarily on the Jemez Ranger District. Egg mass surveys showed an increase in the numbers of egg masses per square meter of foliage from 9.7 in 1979 to 27.2 in 1980. This represents a buildup ratio of 2.8:1. The heaviest and most visible defoliation in this unit occurred along State Road 126 for about 3 miles east of Fenton Hill. Some moderate and heavy defoliation also occurred on Schoolhouse Mesa.

Although budworm populations are not as heavy in the Central unit, they can be expected to continue to increase. Most heavy and moderate defoliation in 1981 can again be expected along State Road 126 and Schoolhouse Mesa. It will probably be 1 or 2 more years before infestation levels in this unit reach those already occurring in the Jemez East unit.

2/ Unpublished data.

Table 1: Summary of egg mass density and aerial detection surveys on the Jemez East, Central, and West entomological units, Santa Fe National Forest, 1980.

		JEMEZ EAST ENTOMOLOGICAL UNIT				
		1976	1977	1978	1979	1980
New egg masses/sq. m foliage		16.9	12.7	12.1	18.9	58.3
Buildup ratio [a/]			0.7:1	0.9:1	1.6:1	3.1:1
Actual defoliation [b/] (acres)	L	2,520	56,872	3,309	1,638	22,880
	M	2,440	1,556	503	512	18,635
	H	0	0	0	0	2,560

		JEMEZ CENTRAL ENTOMOLOGICAL UNIT				
		1976	1977	1978	1979	1980
New egg masses/sq. m foliage		---	4.3	6.1	9.7	27.2
Buildup ratio [a/]		---	---	1.4:1	1.6:1	2.8:1
Actual defoliation [b/] (acres)	L	0	435	512	716	4,865
	M	0	589	418	0	2,230
	H	0	0	0	0	510

a/ Buildup ratio is the ratio of new egg masses in the survey year to new egg masses of the previous year.
b/ Actual defoliation as determined from aerial detection survey. L = light; M = moderate; H = heavy.

Table 1 (continued).

		JEMEZ WEST ENTOMOLOGICAL UNIT				
		1976	1977[c/]	1978	1979	1980
New egg masses/sq. m foliage		12.6	1.7	0.5	0.6	4.9
Buildup ratio [a/]			.1:1	.3:1	1.2:1	8.2:1
Actual defoliation [b/] (acres)	L	8,400	1,894	0	486	4,500
	M	3,800	218	0	563	1,460
	H	240	0	0	0	0

a/ Ibid.
b/ Ibid.
c/ Jemez West entomological unit treated with an aerial application of carbaryl for control of WSBW in 1977.

Jemez West Entomological Unit.--This unit includes part of the Cuba Ranger District and the Jemez Indian Pueblo. For the past 4 years, budworm populations have remained at low levels as a result of the spray project. Egg mass densities increased from 0.6 egg masses per square meter of foliage in 1979 to 4.9 in 1980. Although 4.9 egg masses per square meter of foliage is still considered a light infestation, the increase represents a buildup ratio of 8.2:1. Visible light and moderate defoliation was scattered throughout the unit with the largest area of defoliation occurring from San Miguel Mountain east to the Rio de las Vacas.

Coyote Ranger District.--The infestation on the Coyote Ranger District was first observed in 1976. It is located on the northern edge of the San Pedro Parks Wilderness Area and is considered as a separate infestation from the one in the Jemez West entomological unit. Acres of defoliation were: light, 2,870; moderate, 6,425; and heavy, 3,610, for a total of 12,905 acres. Egg mass surveys were conducted for the first time on this District. There was an average of 78.0 egg masses per square meter of foliage. This indicates that the infestation will continue to increase in size and intensity in this area.

Barring any natural factor(s) that could bring about the collapse of the outbreak on the Forest, it is expected to continue for several more years. Areas of heaviest defoliation, especially on the Jemez East unit, may begin to experience some tree damage.

MANAGEMENT ALTERNATIVES

Maintain Present Management.--With this approach, the outbreak would be allowed to run its course until a population collapse occurred from a combination of: a) a lack of foliage to maintain a larval population; b) unfavorable weather conditions; c) heavy predation and parasitism; and d) a microbial epizootic. Adverse and beneficial effects of the outbreak would have to be accepted. These are:

1. This alternative would not be effective in preventing additional tree damages. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damages resulting from the western spruce budworm in the Southwest are currently unknown, maximum damages similar or higher than those estimated for the northern Rockies could occur if the outbreak continues unabated. These include the following:

Tree damages	Maximum damages (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree use reduction	90+

2. There would be no direct costs associated with selection of this alternative although timber values will be affected and revenues reduced when severely damaged stands are harvested. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual qualities and economic and social impacts would result if this alternative was selected.

Silvicultural Management.--Silvicultural treatments in mixed conifer stands should be designed to create stand conditions that reduce tree damages over the long-term. For example, prescriptions should: a) open up stands by logging, thinning, and burning; b) maintain stand densities favoring ponderosa pine and aspen; c) favor prescribed burning to reduce the percentage of firs and Engelmann spruce; d) regenerate stands by artificial means using ponderosa pine stock; e) favor even-aged stands; and f) salvage damaged and insect-killed trees.

Effects of this alternative are:

1. The trend of the current outbreak would not be changed if a silvicultural program was initiated. Tree damages would be the same as those listed under the "Maintain Present Management" alternative.

2. Conversion of mixed conifer stands to a less susceptible state would be very costly; however, long-term benefits could be achieved.

3. Visual qualities and economic and social impacts would result if this alternative were selected.

Direct Suppression.--Aerial application of a chemical pesticide registered by the Environmental Protection Agency (EPA) could be done to suppress the entire outbreak on the Forest or separate entomological units in 1982. However, if a treated area adjoins an area that is untreated, for instance, the Coyote Ranger District adjoining the San Pedro Parks Wilderness area, one or two additional treatments may be required since treated stands could be reinfested from the nearby untreated stands.

Application would be carefully timed to the development of the larvae, i.e., when 20 percent of the larvae are in the fifth and sixth instars. This would insure maximum effectiveness with a minimum dosage of insecticide. An application of this type is designed to utilize indigenous natural control agents to further reduce and maintain the budworm population at a low level.

Effects of this alternative are:

1. If a direct suppression program were to be carried out on the Forest in 1982, tree damages and losses occurring prior to treatment could not be prevented.

2. It would cost about $10.00 per acre to suppress the current outbreak. However, the permanent tree damages which occur during 1981 may determine whether or not it is economical to consider the direct suppression alternative.

3. Adverse environmental effects resulting from the aerial application of an insecticide would be minimal and temporary.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide)

The Sevin ® 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe National Forest was successfully suppressed in 1977, and the outbreak has remained at a low level for 4 3/ years (Parker and Ragenovich 1980). Carbaryl is a non-persistent pesticide which is available for general use. One (1) pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene ® (acephate) is a nonpersistent insecticide registered for use against the western spruce budworm and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad spectrum insecticide, registered for use against more than 100 insects, including the western spruce budworm. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

3/ 1980 field data unpublished.

4. Microbial Insecticides

Microbial insecticides, such as Bacillus thuringiensis (B.t.), a bacterium, and viruses need further research testing and field evaluation before they are ready for use. In June 1980, several B.t. formulations were tested by the Pacific Northwest Forest and Range Experiment Station in conjunction with CANUSA[4/]. The results of this testing are still being evaluated.

Treatment of High Value Trees.--In recreation areas, VIS Centers, and other areas where defoliation of high value trees would be unacceptable, individual or small groups of budworm-infested trees could be treated by a ground application of an EPA-registered insecticide to reduce the larval density and prevent the adverse effects of defoliation.

Effects of this alternative are:

1. Because only selected high value trees within an infestation could be treated, this would require yearly applications during the outbreak cycle, since treated trees would be reinfested from the nearby infested stands.

2. Application costs associated with this alternative would be relatively low and cost-effective.

3. Adverse environmental effects would be minimal and temporary.

RECOMMENDATIONS

Management of the Current Western Spruce Budworm Outbreak

1. Short-term Pest Management.--The infestation on the Jemez East entomological unit has not yet resulted in tree damages. In order to prevent potential tree damages on this unit, the recommended management alternative is direct suppression with an insecticide in 1982. After 1982, it may no longer be practical to initiate direct suppression, even though defoliation and tree damages are heavy.

Infestation levels on the Jemez Central and Jemez West entomological units have not reached the levels of those on the Jemez East unit. The recommended management alternatives for these units is to maintain present management.

Potential tree damages similar to those on the Jemez East unit can be expected on the Coyote Ranger District. However, direct

4/ The Canada/U.S. Spruce Budworms Program (CANUSA--West) is a 6-year research and development program that is funded through 1983.

suppression is only a preferred alternative if the entire infestation, including the wilderness area, is treated. Entomologically and economically, partial treatment would not be effective, since reinvasion from populations in the wilderness would require one or more additional treatments. The recommended alternative is to maintain present management.

2. Long-term Pest Management.--Long-term silvicultural management for western spruce budworm can be accomplished by including pest management considerations into timber and fire management programs. For example, management programs should facilitate the removal of susceptible old growth and favor ponderosa pine, Douglas-fir, and aspen in vigorous mixed conifer stands.

REFERENCES

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McKnight, M. E., J. F. Chansler, D. B. Cahill, and H. W. Flake, Jr. 1970. Sequential plan for western spruce budworm egg mass surveys in the central and southern Rocky Mountains. USDA Forest Serv. Res. Note RM-174. 5 pp.

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A P P E N D I X

1980 Aerial Detection Survey — Western Spruce Budworm Defoliation
O L, M, H

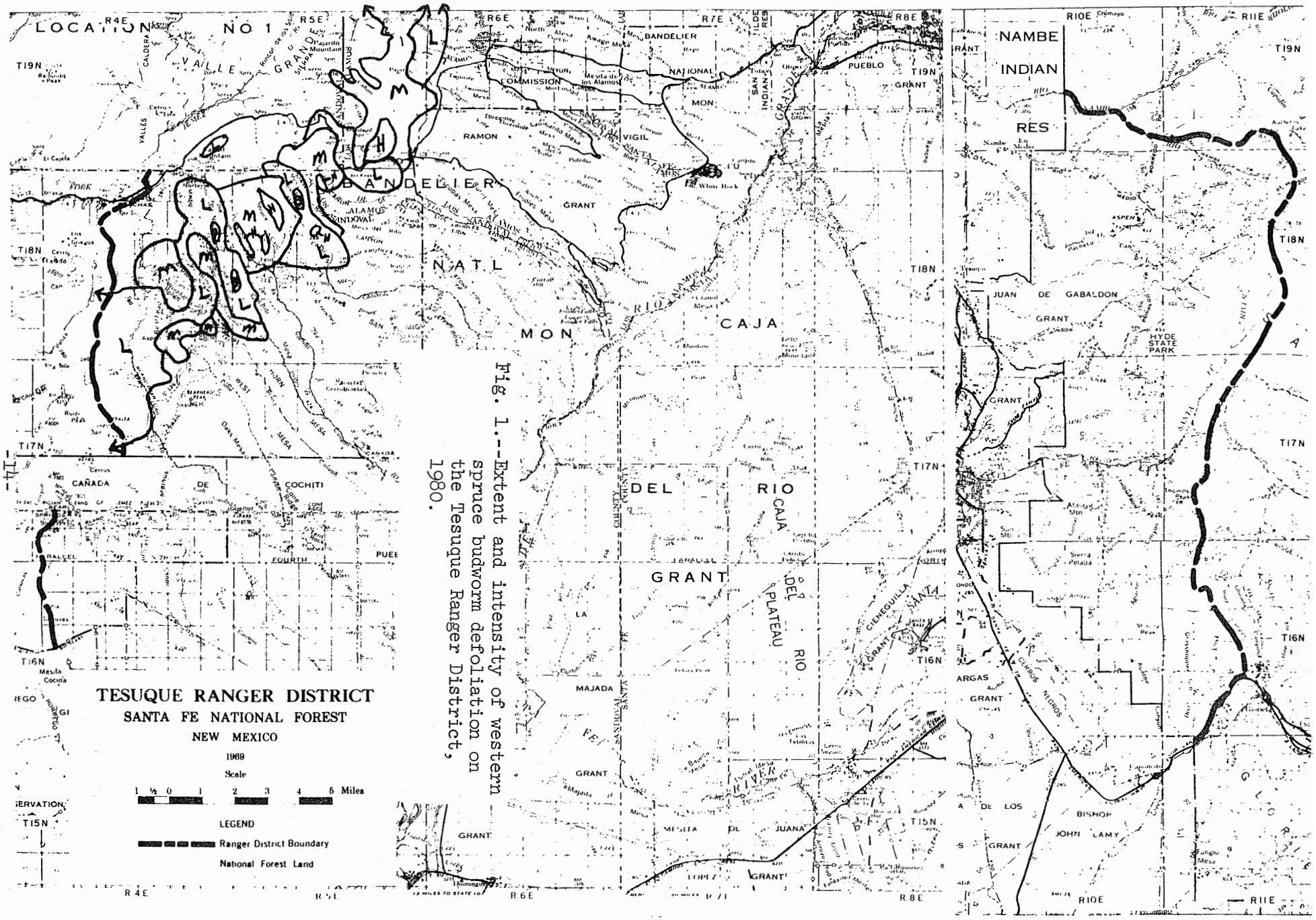


Fig. 1.--Extent and intensity of western spruce budworm defoliation on the Tesuque Ranger District, 1980.

D Aerial Detection Survey

Western Spruce Budworm Defoliati
O L, M, H

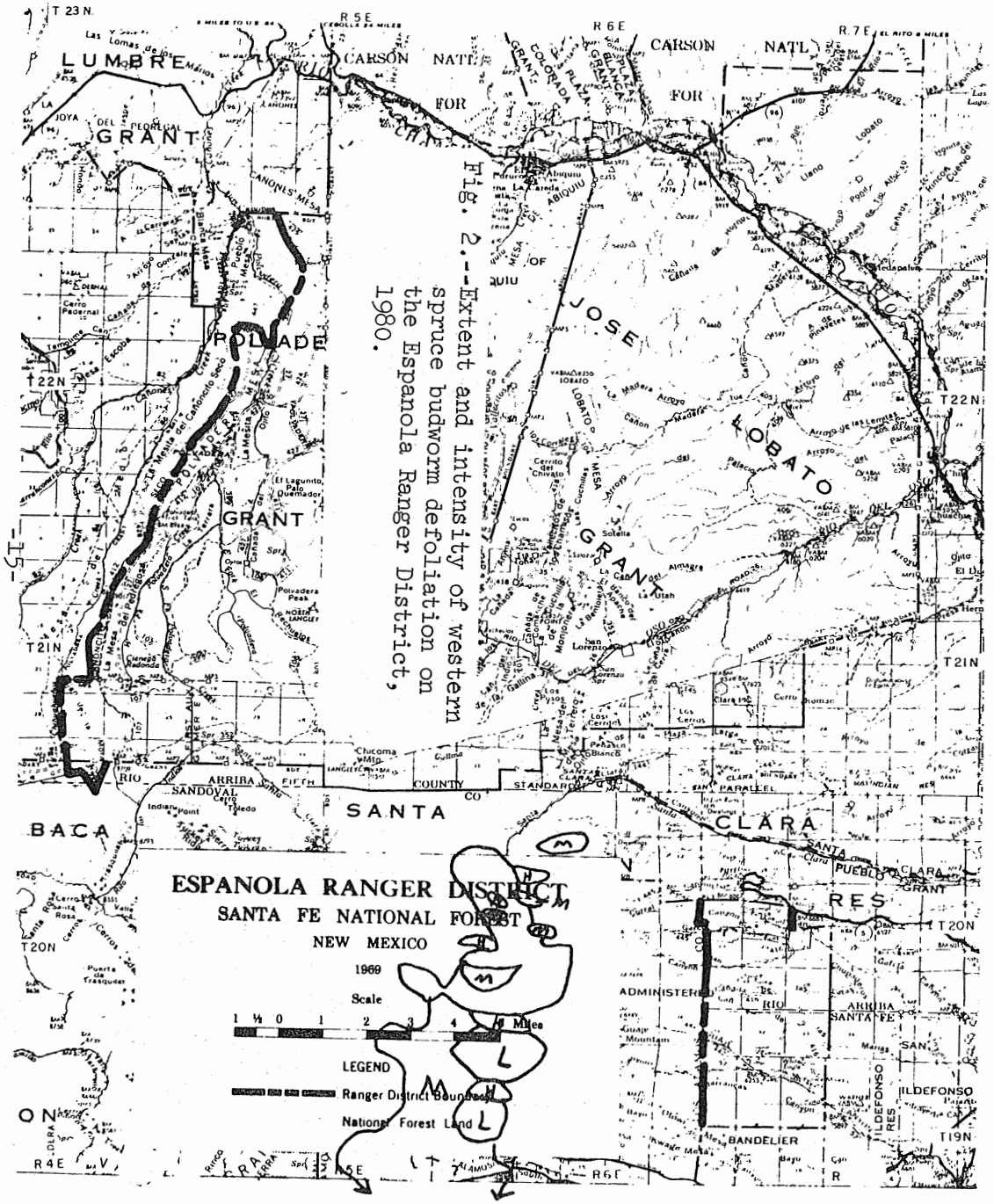
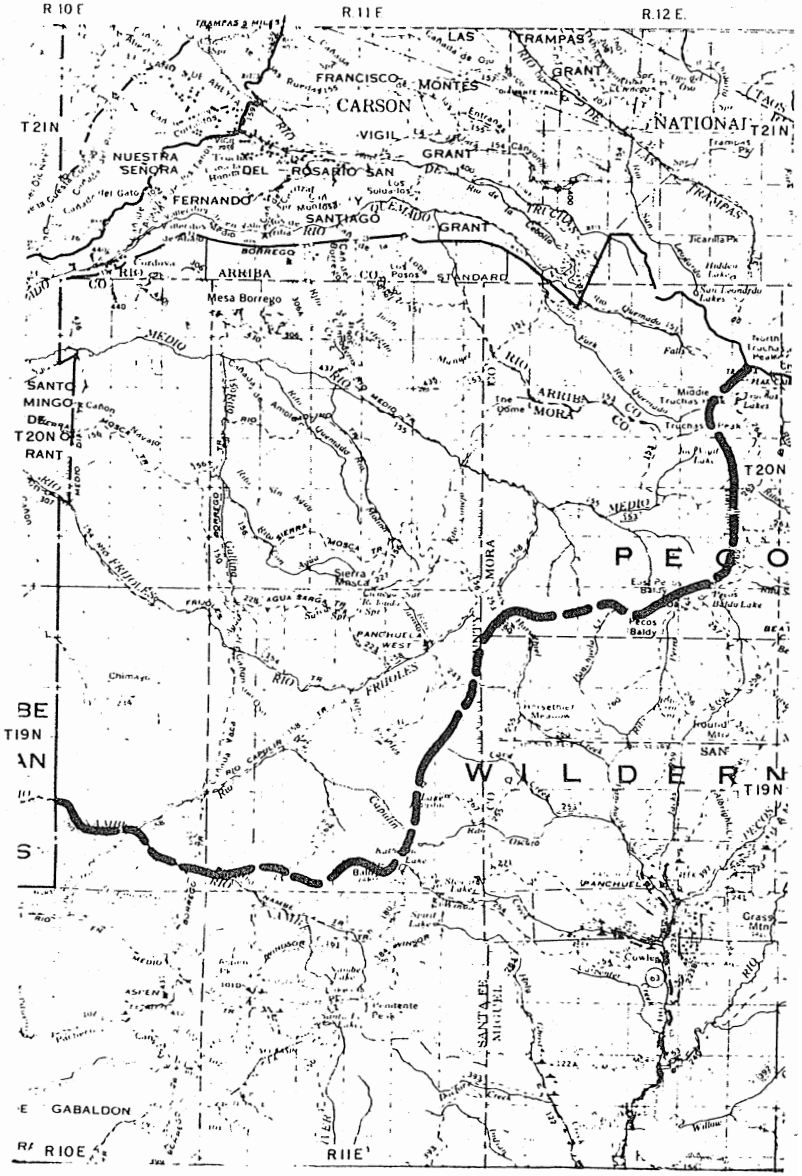


Fig. 2.--Extent and intensity of western spruce budworm defoliation on the Espanola Ranger District, 1980.



1980 Aerial Detection Survey Western Spruce Budworm Defoliation O L, M,

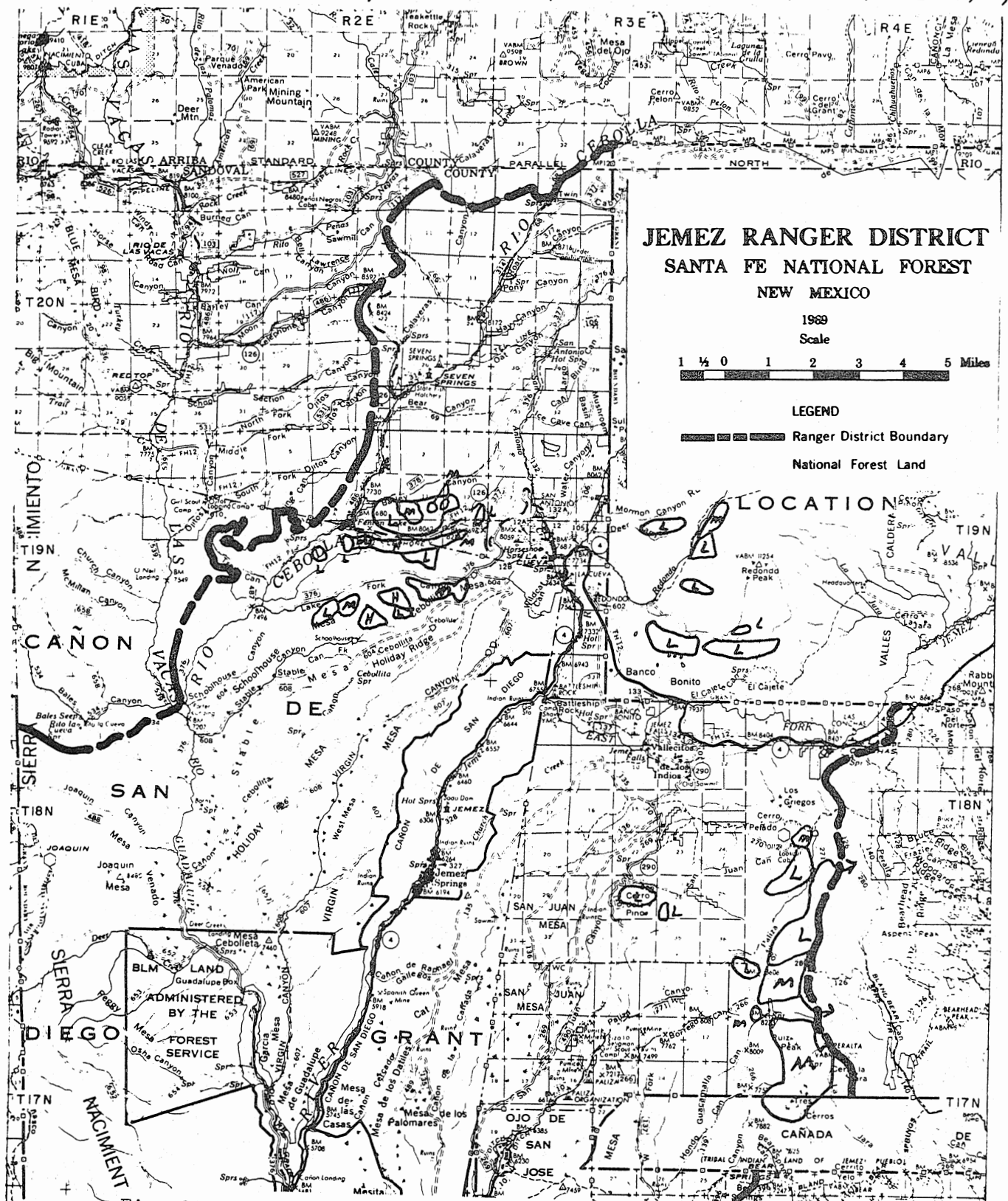


Fig. 3.--Extent and intensity of western spruce budworm defoliation on the Jemez Ranger District, 1980.

1980 Aerial Detection Survey

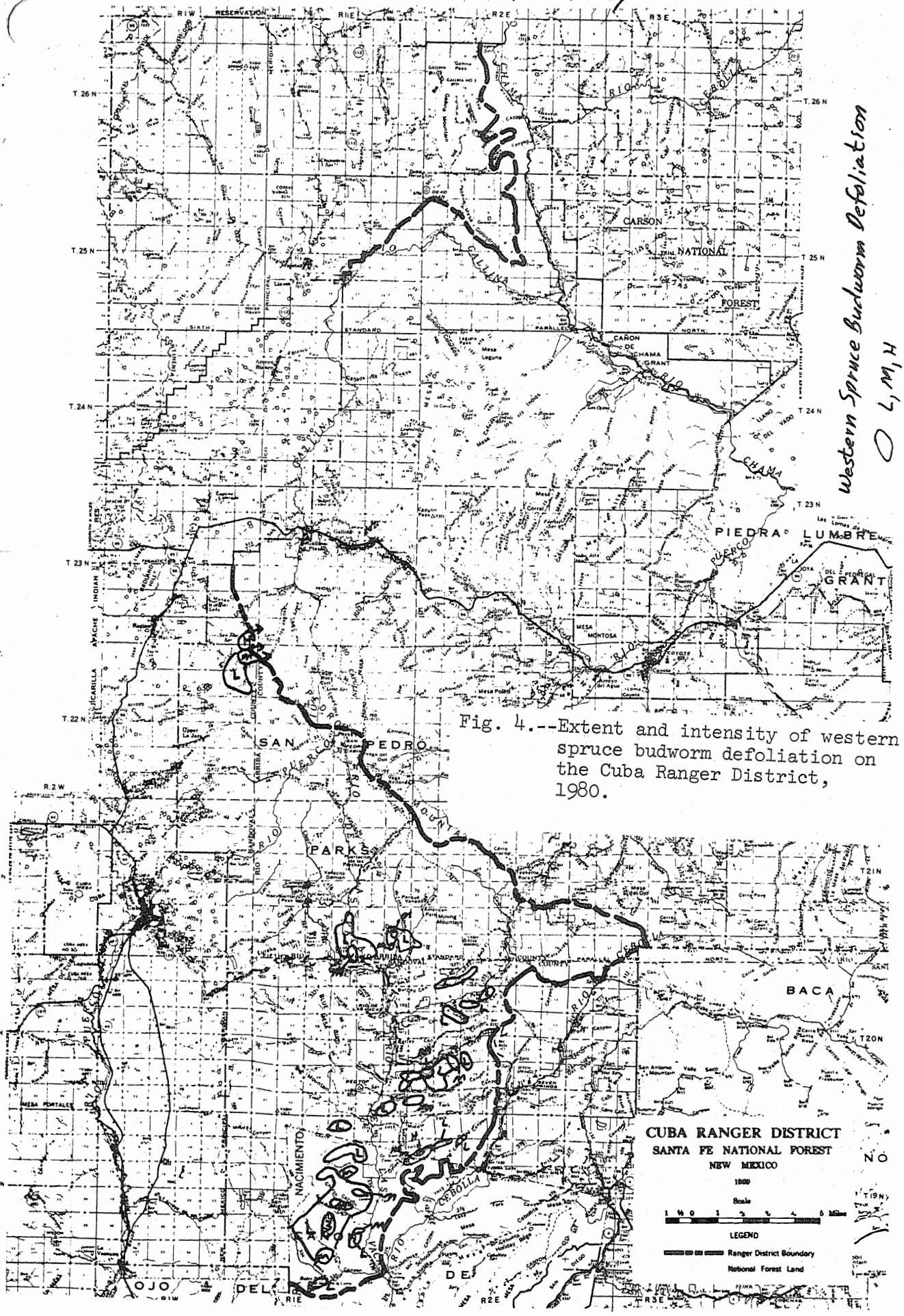


Fig. 4.--Extent and intensity of western spruce budworm defoliation on the Cuba Ranger District, 1980.

1980 Aerial Detection Survey

Western Spruce Budworm Defoliation
O L, M, H

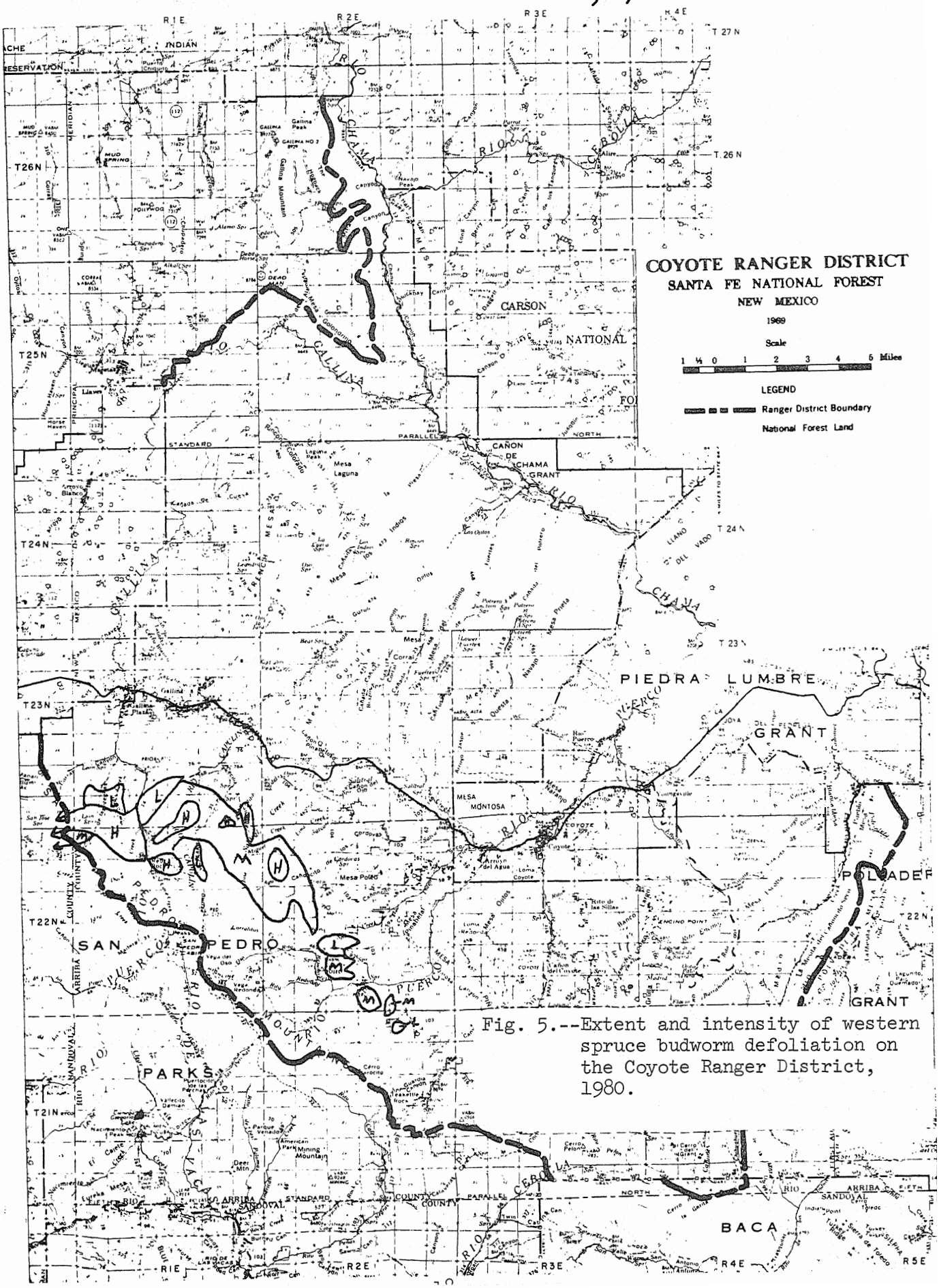


Fig. 5.--Extent and intensity of western spruce budworm defoliation on the Coyote Ranger District, 1980.